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THE SKELETON OF STYRACOSAURUS WITH THE DESCRIPTION OF A NEW SPECIES

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INTRODUCTION

One of the dinosaur skeletons collected in the summer of 1915 from the Belly River formation by an American Museum Expedition under the leadership of the senior writer, in the Red Deer River country, Alberta, Canada, has recently been prepared and mounted for exhibition. This specimen was identified in the field as *Monoclonius* because of the extraordinary similarity to that genus as seen in the exposed parts when the skeleton was collected. Last summer when the blocks of matrix containing this ceratopsian were opened in the laboratory and preparation began, it was discovered that the specimen was an unusually perfect skeleton of *Styracosaurus*. Subsequent preparation has shown that it represents a new species, a description and study of which is given in the following pages.[1]

DESCRIPTION AND COMPARATIVE STUDY

CERATOPSIA

Ceratopsidae

Styracosaurus parksi,[2] new species

TYPE.—Amer. Mus. No. 5372, nearly complete skeleton with parts of the skull and left lower jaw. Collected by Barnum Brown, 1915.

HORIZON AND LOCALITY.—Belly River formation, Upper Cretaceous. Middle Fork of Sand Creek on the right bank, approximately 250 feet above the Red Deer River, 12 miles below Steveville, Alberta, Canada.

DIAGNOSIS.—Squamosal long and broad. Possesses three large, blunt, and flattened projections on its postero-external margin. Posterior end of central bar of frill massive and rounded. Anterior lateral bar of frill with large, oval, epoccipital base near its union with the squamosal. Lateral temporal fossa small. Jugal broad and deep.

The genus *Styracosaurus* was described by Lambe in 1913. The genoholotype consists of a fine, although somewhat crushed, skull that lacks the rostral bone and the lower jaws. This specimen was collected

[1] As a matter of record, it should be noted that the type of the earliest known marsupial, *Eodelphis browni* Amer. Mus. No. 14169, described by Matthew (1916, pp. 482–491) was found under the pelvis of this skeleton.

[2] Named for the late Dr. W. A. Parks.

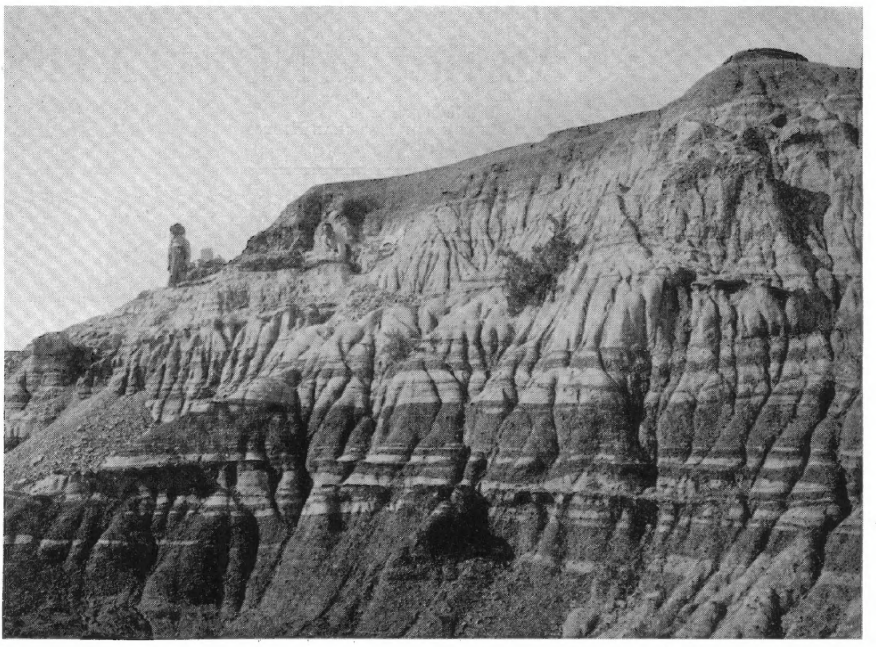

Fig. 1. Collecting of *Styracosaurus parksi*, new species, from the typical variegated sandstone, sands, and clay of the Belly River formation. Right bank of Middle Fork of Sand Creek, approximately 250 feet above the Red Deer River, 12 miles below Steveville, Alberta, Canada.

Fig. 2. Same as shown in Fig. 1. Mr. A. H. Johnson standing by the partially collected skeleton of *Styracosaurus parksi*, new species.

from the Belly River formation on the Red Deer River, Alberta, Canada, during the summer of 1913 by Mr. Charles M. Sternberg. In 1935 an expedition from the University of Toronto visited the site of the discovery and found, through further excavation nearby, the jaws and a goodly portion of the skeleton of the same individual disarticulated and scattered over a considerable area. Through the courtesy of the Toronto Museum and the late Dr. W. A. Parks, some of this material has been loaned to us for comparison and has been useful as a guide in restoring certain parts of the American Museum specimen.

While our specimen comes from the same formation and from the same general locality as the type, there is no question of its being specifically distinct. With the exception of the quite fragmentary skull, and the absence of most of the first three coössified cervicals, and the distal end of the tail, the specimen is unusually complete. Most of the desired information about what is perhaps the most unusual of all the ceratopsians is revealed in this fine skeleton which is now fully prepared and placed on exhibition. A discussion of its more salient features is included in the following.

The skull was almost completely exposed but the squamosal, quadrate, quadratojugal, jugal, posterior portion of the maxillary, and lower jaw of the left side were undisturbed and uncrushed. The rest of the skull was eroded away, although many of the fragments were recovered from down the hillside. Most of these broken fragments have been pieced together and have been identified as to position, but many cannot be placed accurately in the restored skull.

A considerable amount of the inferior left and outer right sides of the rostral is preserved. Only the front tips of the nasals, which are in contact with the rostral, are present, but parts of the nasal horn show that it was large and of the usual oval form. The postorbital presents a rather large and roughened dorsal knoblike elevation, which shows that it probably was capped by some sort of epidermal padlike development. The orbital border of the postorbital and the orbital border preserved on a fragment of the lacrymal and on the jugal indicate that the orbit was large and round in form. The jugal is broad proximally, deep, and pointed distally. In these features it is quite distinct from that of *S. albertensis*, which is rather narrow and is quite uniform in width throughout much of its distal region—a general form that is more like the jugal of *Triceratops*. The epijugal is small and is somewhat pyramidal in general form.

The squamosal, when compared with that of *S. albertensis*, is dis-

tinctly longer, and is sub-quadrangular in outline. In *S. albertensis* it is broader than long and is markedly pointed posteriorly. Likewise, the external border in the Ottawa specimen presents five convexities while in *S. parksi* there are three large, blunt, dorso-ventrally compressed projections. The anterior of these is the smallest, the posterior one the largest.

Of the middle frill element, only the posterior bases of projections I, III, and IV, and the antero-lateral extensions on the left side are preserved. From these it is possible to ascertain the diameters of the projections. The posterior end of the central bar is massive and rounded; just mesially to the base of process I there is an incompletely preserved anterior process that probably extended only a short distance over the frill fenestra. This projection is not present on the frill of *S. albertensis*. Also, process IV in *S. parksi* is larger and straighter. Anterior to it there is a large, oval, epoccipital base near the union with the squamosal—a character that seems distinct in this species.

The left lower jaw is quite complete. Although most of the alveolar portion is broken away, the inferior margin is complete. The post-predentary length therefore is known. When compared with the jaw of *S. albertensis*, the coronoid portion of the dentary is seen to be more robust and the dentary is shorter and has greater depth. The lower portion and the very tip of the predentary are known but display no distinctive features.

In order to restore our new skull it became necessary to visit Ottawa to study and to make comparisons with the type specimen. This was done by the senior writer, and was made possible through the courtesy of the National Museum of Canada officials, and Mr. Charles M. Sternberg in charge of the vertebrate collection.

In the original description Lambe comments on the distortion of the skull, through vertical pressure, and the consequent overlapping of bones in the anterior part of the skull. In his restored outline, side view, of the skull (Lambe, 1913, Pl. XII), however, the maxillary has not been given sufficient depth anteriorly, and the premaxillary crushing has not been corrected. By actual measurement of overlap between the nasal and premaxillary this specimen shows that originally the narial opening was almost circular, as in *Monoclonius* and *Centrosaurus*. The nasal horn has been crushed downward and forward at the base, and the posterior and anterior contour at the broken upper end shows clearly that it was not a straight blunt forward pitching element as restored. The terminal end has been restored approximately three inches too long.

In outline, the front part of this skull and the nasal horn should approximate the form of *Monoclonius nasicornus* Brown. Lambe's outline of the corrected position of the frill is approximately right with exception of the long posteriorly directed terminal spikes which have been restored incorrectly in form. Following the contour of the preserved bases, the terminal ends probably should curve forward laterally to a greater degree than they are restored, and should be somewhat reduced in length.

Taking these features of the type into consideration and using it as the principal guide, the skull of *Styracosaurus parksi* has been restored as shown in Fig. 3. Knowing the length of the jaw and parts of the predentary and rostral, it was possible to estimate the antorbital skull length, and the well-preserved jugal, quadratojugal, and quadrate indicate that that region is quite deep as in *Monoclonius*. The complete squamosal in articulation with the jugal, together with most of the lateral branch of the middle frill element, enabled us to make a close approximation of the frill length. The estimated length of the spikes is based on the size of the bases and on a fragmentary frill of another specimen (Amer. Mus. No. 5361) in the American Museum collection. The overlapping of the third by the second projection, however, is copied directly from the Ottawa specimen. It is entirely possible that these projections were equally spaced as is suggested in No. 5361, and as shown in *S. ovatus* Gilmore (1930, Pl. x), although it is certain that the first pair did not converge as in that species.

With the exception of coössified cervicals one, two, and the front part of three, the vertebral column is complete and articulated to and including the twentieth caudal. The tenth postcranial vertebra is the first to have the capitular facet on the neural arch, although that facet is somewhat lower down than on the remaining dorsal vertebrae. This vertebra is unquestionably the first dorsal. There are, therefore, nine cervicals and the number of dorsals is twelve. The centra of the fourth and fifth dorsals are coössified which is undoubtedly a pathological condition. This is not uncommon among the larger ceratopsia (Lull, 1933, p. 40), and may in some way be connected with the development of an unusually large head. Of especial note, in this connection, is the presence of ossified tendons across the neural spines of the anterior dorsal vertebrae. The twelfth dorsal is entirely free from the first sacral. It bears a long rib on either side which is entirely free from, and extends considerably below, the ilium. This is very different from the condition in *Monoclonius* (*Centrosaurus*) *flexus* in which the neural arch is fused to the first sacral and the ribs are short and united with the inferior sur-

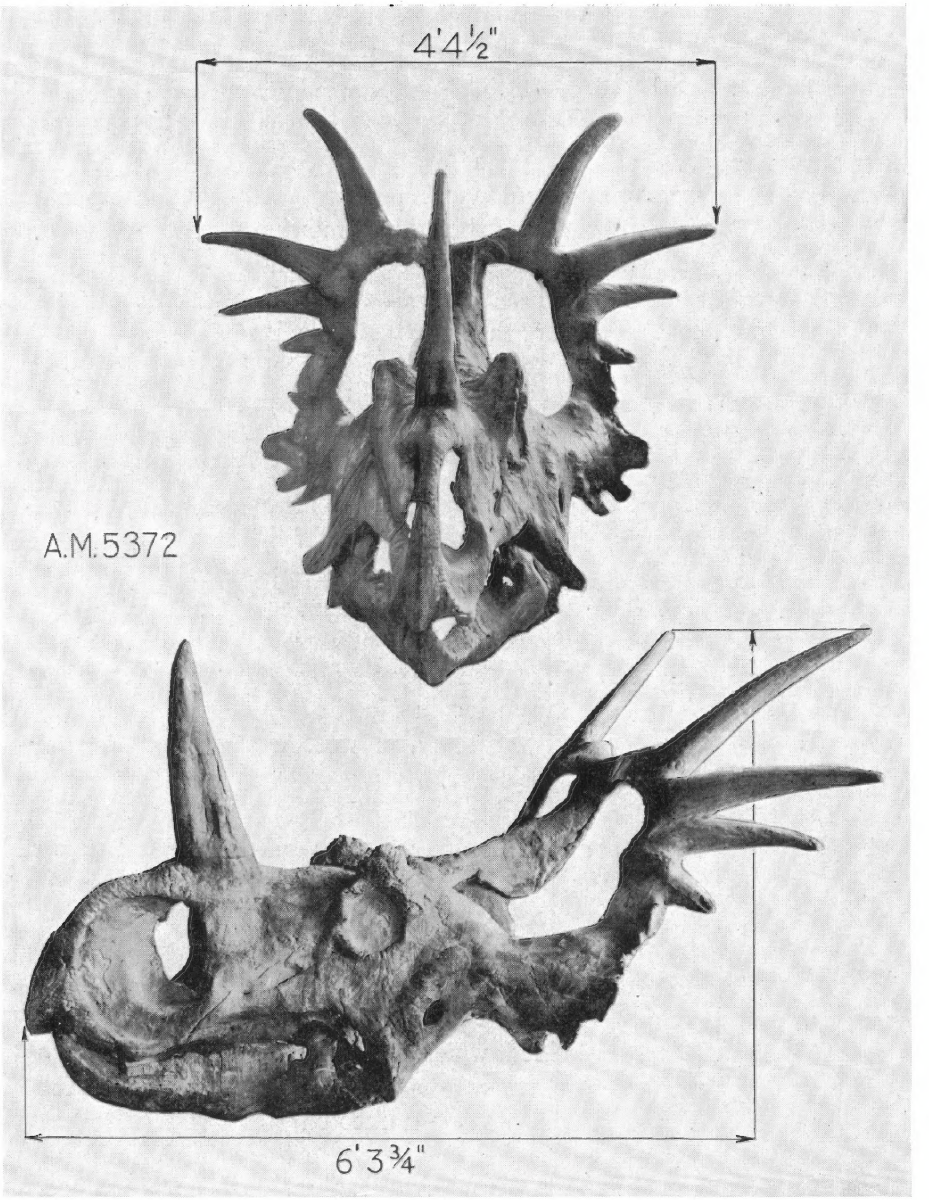

Fig. 3. *Styracosaurus parksi*, new species. Anterior and lateral views of the restored skull.

faces of the ilia (Lull, 1933, p. 48). In *M. nasicornus* the ribs of the last dorsal are short and curve out in front of the ilia.

The sacrum is composed of ten vertebrae as is normal for all the later ceratopsians. A sacral character, however, that seems distinctive of *Styracosaurus* is that the tenth is incompletely fused with the ninth and retains the general form of the first caudal. In this respect the sacrum of *Styracosaurus* is more primitive than in *Monoclonius*, yet more advanced than in *Brachyceratops* which has eight sacrals (Gilmore, 1917, p. 21).

The first twenty caudals were all articulated and completely preserved. Twelve complete, and parts of three other caudal centra are also present. These have been placed, and the total number has been restored to forty-six, following that of *Monoclonius nasicornus*. As in that species, the first chevron appears between the third and forth caudals. The only distinctive feature of the caudal series is the rapid reduction in size of the vertebrae. The first three are about as in *Styracosaurus albertensis*, but the fifth, sixth, seventh, and eighth are about one fourth smaller than in that species.

The pelvis of *Styracosaurus* displays several distinctive features. The ilium is proportionately wider anterior to and across the crest above the acetabulum than in *Monoclonius*, which character is in keeping with the large size of the animal. The posterior portion is not as outwardly deflected, nor is it as extended posteriorly. It is quite erect, short, and heavy, more as in *Brachyceratops*. In this respect the ilium is primitive —a condition to be expected in a ceratopsian in which only nine of the sacral vertebrae are firmly coössified, instead of ten as in such forms as *Monoclonius* and *Triceratops*.

The "prepubis" is stronger and the distal end is more expanded than in *Monoclonius*. This feature, however, is probably of little or no phyletic significance, since such an expansion simply means the presence of greater abdominal support,—a corollary of size increase.

These primitive conditions of the pelvis are likewise expressed in the ischium. Compared with the ischium of *Monoclonius*, this element displays some rather marked differences. It is heavier, especially in the distal portion, less decurved, and the antero-inferior projection for articulation with the pubis is not as extended. In addition, the notch between the pubic and iliac facets is deeper. Also, the distal end is not deflected inward—a feature particularly well shown in *M. cutleri*. All these characters seem to show that the *Styracosaurus* ischium is closer to that of *Brachyceratops* than to *Monoclonius*.

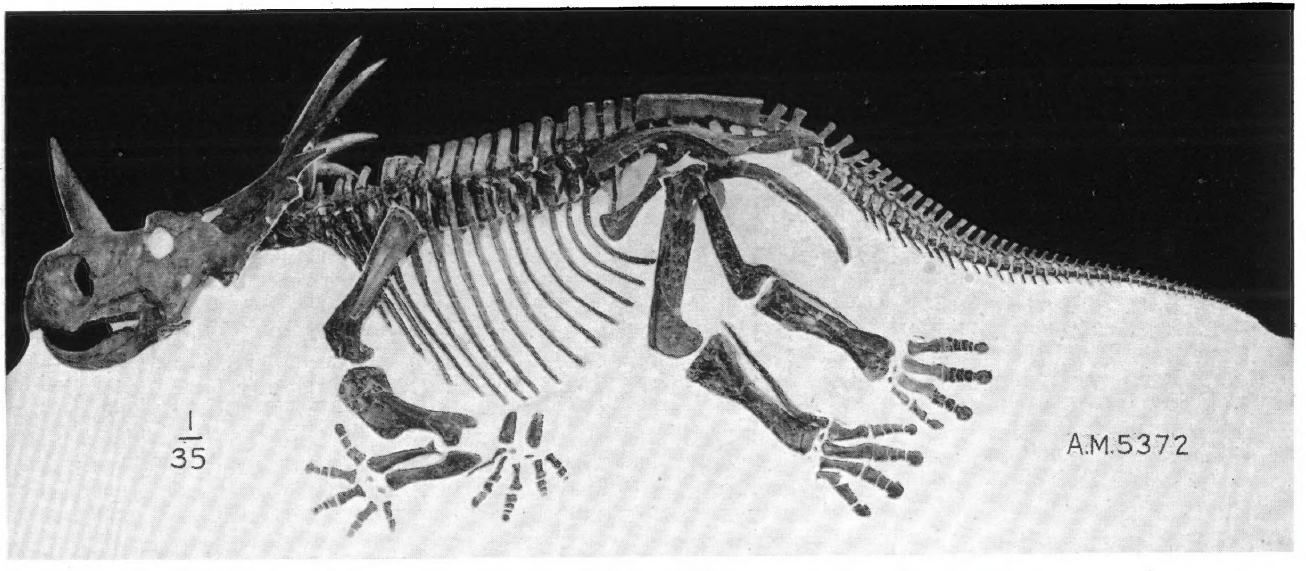

Fig. 4. *Styracosaurus parksi*, new species. Right view of the mounted skeleton.

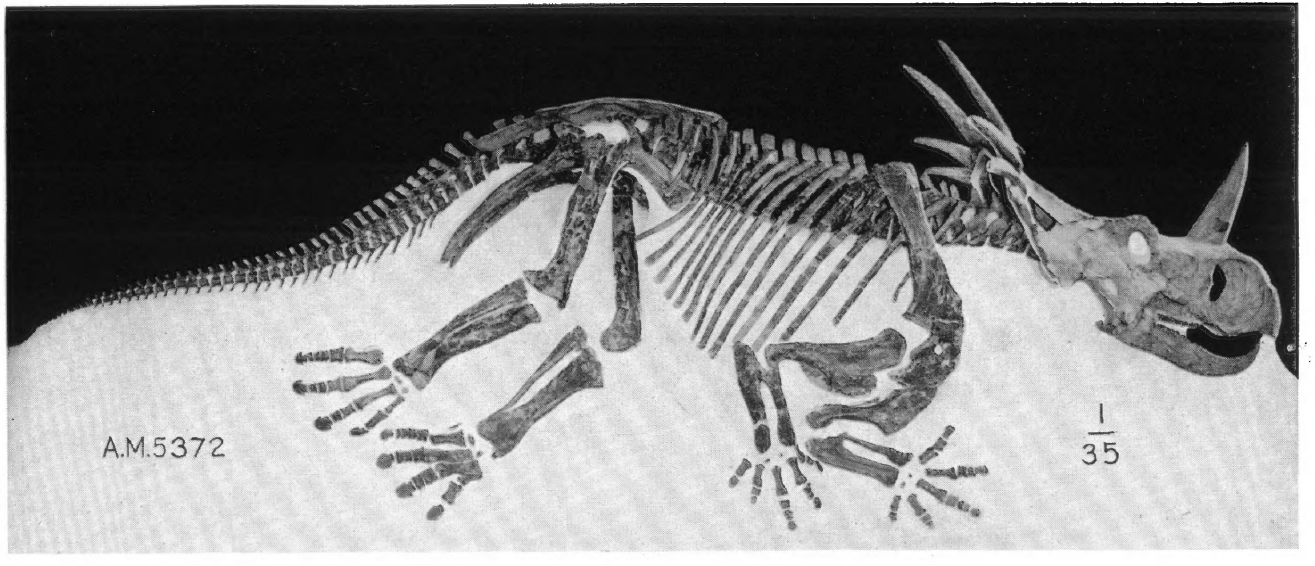

Fig. 5. *Styracosaurus parksi*, new species. Left view of the mounted skeleton.

The appendicular skeleton is completely preserved although lateral crushing has caused a considerable amount of variation in the dimensions of the same elements on opposite sides. It is strikingly like that of *Monoclonius*. The only apparent differences are, that the second digit of the hind foot is proportionately somewhat longer, and the proximal end of metacarpal II is wider than that of metacarpal III. So very similar are the feet in the two genera that a front and hind foot of this skeleton, designated as *Monoclonius* sp., was prepared and illustrated as a check on the carpals and restored parts of the metacarpals in the senior writer's description of the type skeleton of *M. nasicornus* (Brown, 1917, Pl. XII). Apart from these slight differences and the distinctive features of the skull and pelvic bones, the remainder of the skeleton in nearly every way resembles *Monoclonius* so closely that if individual bones were found separately one could not determine which genus they represent.

In preparing and mounting the skeleton the bones have been retained in the exact position and association as found with exception of the right femur, which had been crowded through to the left side, and the left front limb which was found disarticulated. This limb has been posed to give balance to the mount (see Figs. 4 and 5).

This new species is the third to be assigned to *Styracosaurus*[1] and aids greatly in elucidating the characters of the genus, which originally were based on the skull alone and were given by Lambe (1913, p. 109) as follows:

"Skull massive, elongate, pointed in front, and greatly extended behind to form a neck-frill with long, robust, tapering outgrowths projecting obliquely backward and outward from its posterior border. Fontanelles of moderate size within the coalesced parietals. Squamosals somewhat quadrangular and entering largely into the formation of the front part of the frill. Postfrontal fontanelle large. Supratemporal fossa opening widely behind. Nasal horn-core large, upright, straight, rising from the back of the nasals. Supraorbital horn-core incipient."

Since the frill processes III in *Styracosaurus ovatus* Gilmore converge instead of diverge at their tips it would seem that the part of the above definition concerning the back region of the frill should be given as, "neck-frill with long, robust, tapering outgrowths projecting from its

[1] Lambe referred *Monoclonius sphenoceros* Cope, of which only the nasal with the horn, and the left premaxillary are known, to the genus *Styracosaurus*. We are of the opinion, expressed earlier by the senior writer (1914, pp. 549–550), that this species belongs to *Monoclonius* and should probably be referred to *M. crassus*. Lull (1933, pp. 90–91) has also stated his reasons for assigning this species to *Monoclonius*.

posterior border" instead of, ". . . projecting obliquely backward and outward from its posterior border." Otherwise the above characters, in view of the known material, should stand as given, and to them the following skeletal characters can be added: ninth and tenth sacrals incompletely coössified; posterior portion of ilium short and quite erect; and, ischium not greatly decurved. In these skeletal features *Styracosaurus* seems nearer to *Brachyceratops* than to *Monoclonius*, but in all other characteristics it is evidently most closely related to the latter, and probably represents an aberrant offshoot from the *Brachyceratops-Monoclonius* line.

MEASUREMENTS

	Right	Left
Length of Metacarpal I	81 mm.	92 mm.
" " Metacarpal II	133 mm.	133 mm.
" " Metacarpal III	133 mm.	140 mm.
" " Metacarpal IV	102 mm.	106 mm.
" " Metacarpal V	86 mm.	80 mm.
Length of Phalanx I^1	52 mm.	55 mm.
" " Phalanx I^2	68 mm.	75 mm.
" " Phalanx II^1	42 mm.	44 mm.
" " Phalanx II^2	31 mm.	33 mm.
" " Phalanx II^3	58 mm.	65 mm.
" " Phalanx III^1	42 mm.	00 mm.
" " Phalanx III^2	29 mm.	29 mm.
" " Phalanx III^3	19 mm.	00 mm.
" " Phalanx III^4	44 mm.	49 mm.
" " Phalanx IV^1	38 mm.	00 mm.
" " Phalanx IV^2	25 mm.	00 mm.
" " Phalanx IV^3	16 mm.	00 mm.
" " Phalanx V^1	43 mm.	43 mm.
" " Phalanx V^2	13 mm.	00 mm.
Length of Metatarsal I		128 mm.
" " Metatarsal II		188 mm.
" " Metatarsal III		224 mm.
" " Metatarsal IV		178 mm.
" " Metatarsal V		68 mm.
Length of Phalanx I^1		105 mm.
" " Phalanx I^2		95 mm.
" " Phalanx II^1		70 mm.
" " Phalanx II^2		50 mm.
" " Phalanx II^3		88 mm.

	Left
Length of Phalanx III[1]	65 mm.
" " Phalanx III[2]	40 mm.
" " Phalanx III[3]	39 mm.
" " Phalanx III[4]	87 mm.
" " Phalanx IV[1]	64 mm.
" " Phalanx IV[2]	40 mm.
" " Phalanx IV[3]	30 mm.
" " Phalanx IV[4]	24 mm.
" " Phalanx IV[5]	64 mm.
Length of humerus	618 mm.
" " radius	375 mm.
" " ilium (estimated)	997 mm.
" " pubis and prepubis (estimated)	598 mm.
" " ischium	890 mm.
" " dentary	405 mm.

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